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ASSESSMENT OF $3D$ MODELING FOR ROTOR-STATOR CONTACT SIMULATIONS

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Transient dynamic simulations of accidental slowing down of turbines with rotor-stator contact interactions are dealt with in the literature mainly by means of $1D$ models [1]. However, for a better understanding of local non linear phenomena, a $3D$ model of the contact zone is necessary. After developing a coupled $1D$ and $3D$ model approach to save computation time for rotor dynamics problems with non linearities restricted in space and time [2], this paper aims at illustrating the contribution of a $3D$ finite elements modeling of the rotor-stator contact interactions. This is achieved by comparing the results of a $3D$ finite elements model of a rotor-stator contact problem with those obtained by a simplified $1D$ model.

In order to make a relevant comparison between a $3D$ modeling of a rotor-stator contact problem and a $1D$ model, the $1D$ and $3D$ models of the rotor and of the stator are built in such a way that the natural frequencies, behaviours and responses to an unbalance are practically the same for both $1D$ and $3D$ models. Thus, the only differences are due to $1D$ and $3D$ contact modeling differences.

Three application examples illustrate the contribution of the $3D$ model. In the first application the stator is constituted of a simple ring having its outer surface fixed. In the second application, the stator and its blades are modelled as shown in fig. 1. This same model is used in the third example in which the rotor rotates at its critical speed. The applications examples are inspired from real industrial problems. The dimensions are those of a true EDF nuclear park turbine.

Comparing $1D$ and $3D$ rotor orbits, as illustrated in fig. 2, shows a small difference between the $1D$ and the $3D$ contact approaches. In other words, from a global point of view, the $1D$ and the $3D$ models are equivalent. However, local effects are observed on the $3D$ stator. This is not the case in $1D$ models. Fig. 3 highlights the displacement differences of the same physical point belonging to the $1D$ and the $3D$ stator models, along the stator's tangential direction at that point. It shows a significant difference between

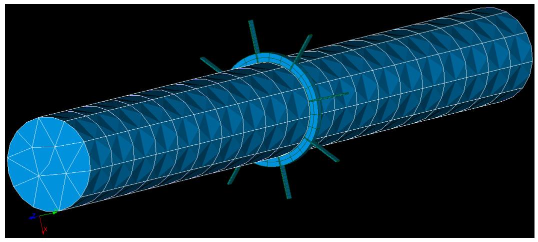

Figure 1: $3D$ model of the rotor-stator system

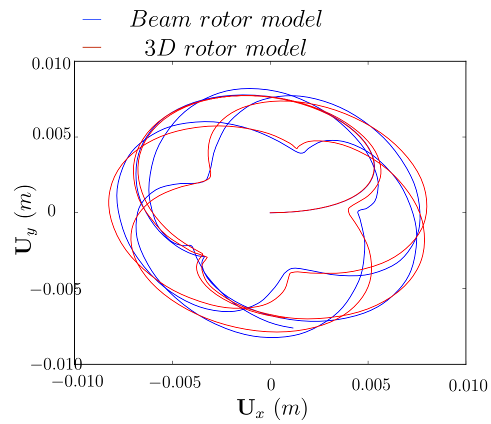

Figure 2: Orbits of the $3D$ rotor and the beam rotor

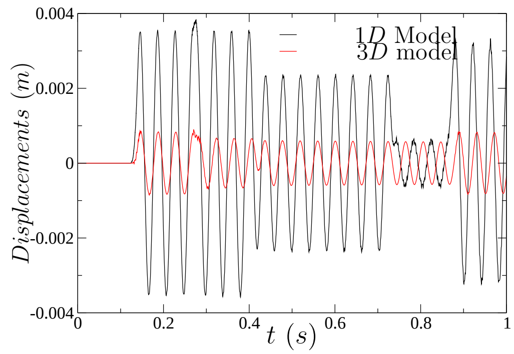

Figure 3: Displacements comparison of a point belonging to the stator

the stator behaviors depending on the contact approach being used ($1D$ or $3D$ modeling). Stator behaviors make it obvious that the contact friction torque is overestimated in $1D$ models. The main cause lies in the rigid body cross-section assumption in a beam modeling used in the $1D$ model.
This research work highlights the necessity of a $3D$ model for a more accurate simulation of a rotor-stator contact problem.
The application examples are conducted on the industrial finite element code Code_Aster using penalty contact algorithms. A comparison with Abaqus/Explicit is in progress.

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